Chemistry 160

# Experiment 1: Le Chatelier's Principle

**Objective**
To study equilibrium and Le Chatlier's Principle.

**Introduction**
In 1884, the French chemist and engineer Henri-Louis Le Châtelier proposed one of the central concepts of chemical equilibria. **Le Châtelier's principle** can be stated as follows:

> **If a system at equilibrium is disturbed by a change in temperature, pressure, or the concentration of one of the components, the system will shift its equilibrium position so as to counteract the effect of the disturbance.**

Le Châtelier's principle describes what happens to a system at equilibrium disturbed and must reestablish equilibrium. For example, if a chemical system is at equilibrium and we add a substance (either a reactant or a product), the reaction will shift so as to reestablish equilibrium by consuming part of the added substance. Conversely, removal of a substance will result in the reaction moving in the direction that forms more of the substance.

In this experiment, you will be observing the results of perturbing a set of 6 different reactions. In most cases the reagents will already be made up for you, but in some cases you will need to make stock solutions. Each one of these systems should give some sort of visual indication when perturbed. Be careful to records detailed observations!

**Pre Lab Questions**
1. Explain Le Chatlier's principle in your own words.
2. Write an equilibrium expression for each reaction.

**Procedure**
There will be 6 stations for 6 reactions. You will go around to each station and the reagents will remain at the proper station.

*Reaction 1:*

$NaCl\ (s) \leftrightarrow Na^{+}\ (aq) + Cl^{-}\ (aq)$

1. Add a few drops of conc. HCl to 2-3 mL of saturated NaCl solution and observe the result.

*Reaction 2:*

$NH_4Cl\ (s) \leftrightarrow NH_4^+\ (aq) + Cl^-\ (aq)$

2. Add a few drops of conc. HCl to 2-3 mL of saturated $NH_4Cl$ solution and observe the result.

*Reaction 3:*

$Fe^{3+}\ (aq) + SCN^-\ (aq) \leftrightarrow FeSCN^{2+}\ (aq)$

3. If you are the first group at this station, prepare a <u>stock solution</u> by mixing 2mL of 0.1M $FeCl_3$ and 0.1M KSCN in a 100 mL graduated cylinder adding $H_2O$ to bring the volume to 100 mL. Save this stock solution for the rest of the class.

4. Take 5mL of the stock solution and note the color. Add about 1mL of 0.1M $FeCl_3$ solution and observe the result.

5. Take 5mL of the stock solution and note the color. Add about 1mL of 0.1M KSCN solution and observe the result.

6. Take 5mL of the stock solution and note the color. Add 0.1M $AgNO_3$ solution dropwise until almost all the color is gone. Split the solution into two test tubes including the precipitate.
    a. Add 2mL of 0.1M KSCN dropwise to one tube and observe the result.
    b. Add 2mL of 0.1M $FeCl_3$ dropwise to the second tube and observe the result.

*Reacton 4:*

$2\ CrO_4^{2-}\ (aq) + 2\ H_3O^+ \leftrightarrow Cr_2O_7^{2-}\ (aq) + 3\ H_2O\ (l)$

7. Add 2 drops of 6M $HNO_3$ to roughly 3mL of 0.1M $K_2CrO_4$ solution and observe the result.

8. Add 10% NaOH solution dropwise to the solution from step 7 until the original color is restored.

9. Add 2 drops of 6M $H_2SO_4$ to roughly 3mL of 0.1M $K_2CrO_4$ solution and observe the result.

10. Add 10% NaOH solution dropwise to the solution from step 9 until the original color is restored.

*Reaction 5:*

$Co(H_2O)_6^{2+}$ (aq) + 4 $Cl^-$ (aq) ←→ $CoCl_4^{2-}$ (aq) + $H_2O$ (l)

11. Add 3 mL of conc. HCl dropwise to 2mL (no more) of 0.1M $CoCl_2$ and observe the result.

12. Add water dropwise to the solution from step 11 until the reverse reaction is evident.

*Reaction 6:*

$NH_3$ (g) + $H_2O$ (l) ←→ $NH_4^+$ (aq) + $OH^-$ (aq)

13. Prepare a stock solution by mixing 4 drops of conc. $NH_4OH$ and 3 drops of phenolphthalein in a 100 mL graduated cylinder and adding $H_2O$ to bring the volume to 100mL.

14. Dissolve a small amount of $NH_4Cl$ in 5 mL of stock solution and observe the result.

15. Add a few drops of 6M HCl to about 5 mL of stock solution and observe the result.

**Post-Lab Assignment**

A. Rewrite the 6 chemical equations. Under each reactant or product write its characteristics such as color. Include HEAT as a reactant or product if it is now known.

B. Answer the following questions: (Typed as part of your lab report)

1. In step 1, which direction did the equilibrium shift? What was the visual indication of this shift?

2. In step 2, which direction did the equilibrium shift? What was the visual indication of this shift?

3. In step 5, which direction did the equilibrium shift? What was the visual indication of this shift?

4. In step 7, which direction did the equilibrium shift? What was the visual indication of this shift?

5. Write a balanced net ionic equation showing what happened in step 6.

6. In step 6a, which direction did the equilibrium shift? What was the visual indication of this shift? Use the equation from question 4.

7. In step 10, which direction did the equilibrium shift? Use balanced equations to explain the direction of this shift.

8. Explain the difference between K and Q.